

## Chapter Eight: Overview of Monitoring Species, Habitats, and Conservation Actions

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In Chapter Seven, we summarized the overall conservation strategies and actions aimed at conserving the Commonwealth's species in greatest need of conservation. These conservation strategies and actions are listed under each habitat type in Chapter 9.

In this section, we provide an overview of monitoring efforts aimed at determining the effectiveness of the proposed conservation strategies and actions. These monitoring efforts are listed under each habitat type in Chapter 9. Some of these monitoring efforts are aimed at individual species or suites of species; some are aimed, more broadly, at the habitats of the species. In both cases, the goals of monitoring are to:

- Determine the current status and population trends of species in greatest need of conservation, as well as their habitats, at several scales;
- Measure, quantitatively and qualitatively, the effectiveness of proposed conservation actions; and
- Over time, change and adapt conservation actions to reflect improved information and changes in populations or their habitats.

### A. Biological Monitoring of Species and Habitats

Massachusetts will continue ongoing ecological and biological monitoring efforts and, as necessary, undertake new efforts that assess biological parameters important to species in greatest need of conservation. In addition, MassWildlife will implement appropriate new monitoring efforts for assessing or determining the abundance, distribution, location, and health of these species and their habitats. Monitoring will be undertaken at a variety of geographic scales, including international, national, regional, state, and local. National and regional monitoring protocols for a variety of species have been established through programs like Partners in Flight (PIF), Southeast and Northeast Partners for Amphibian and Reptile Conservation (PARC), and others. MassWildlife also will also participate in monitoring efforts prescribed in plans developed by the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), Partners in Flight Bird Conservation Regions (BCR), National Bat Conservation Initiative, and others.

#### **Fishes**

Most of the fish species of greatest conservation concern are currently adequately monitored by on-going fishway and fish community surveys conducted by MassWildlife and cooperators. See below for a summary of these surveys.

#### **Fish Community Survey**

Watershed-based fish community assessments involve state, federal, non-governmental organization, and public input during the site selection and prioritization process. The framework for site selection is based on the Massachusetts Department of Environmental Protection (DEP) 5-Year Basin Cycle by which all watersheds will receive some level of

monitoring effort in at least one of every five years. In addition to this, the Division of Fisheries & Wildlife overlays priorities that include but are not limited to:

- 1) requests from DEP as part of their watershed monitoring and assessment procedures;
- 2) requests from Conservation Commissions for stream surveys within their town jurisdiction;
- 3) DFW District priorities;
- 4) recreational fisheries management priorities;
- 5) rare and endangered species information requests; and
- 6) public citizen requests for sampling locations.

These requests are prioritized based primarily on need, degree of prior information, and available personnel. Future efforts will seek to improve the efficiency of this monitoring effort by formalizing the process for selecting watershed-specific index sampling locations to monitor change in fish communities over time.

#### **Fishway Monitoring**

Anadromous/catadromous species (American Shad, Alewife, Blueback Herring, Shortnose Sturgeon, Atlantic Salmon, Sea Lamprey, and American Eel) are adequately monitored by existing fishway evaluation programs. However, abundance estimates of Shortnose Sturgeon on the Merrimack River are based on small sample sizes and thus are not very precise. More monitoring of this population is needed. Monitoring of American Eel will be enhanced as additional eelways are completed on several river systems. Data collected from fishway monitoring is added to long-term data sets maintained with partner agencies such as Massachusetts Division of Marine Fisheries, U.S. Fish and Wildlife Service, and National Marine Fisheries Service.

<b>Fish Habitat</b>	<b>Fish Community Survey</b>	<b>Fishway Monitoring</b>
Connecticut & Merrimack Mainstems	X	X
Large Rivers	X	X
Mid-sized Rivers	X	
Small Streams	X	
Lakes & Ponds	X	

However, Atlantic Sturgeon and Threespine Stickleback are not monitored by these two programs. The specific population of Threespine Stickleback which is of conservation concern occurs only in a few small ponds in an urban park. These ponds are checked for Threespine Stickleback every few years, on an irregular basis, by staff from Mass Wildlife's Natural Heritage & Endangered Species Program. Atlantic Sturgeon are occasional visitors to the lower reaches of the Merrimack and Taunton Rivers in Massachusetts and thus are hard to monitor on a regular basis. MassWildlife will work on developing an appropriate monitoring program for Atlantic Sturgeon.

#### **Amphibians and Reptiles**

Monitoring amphibians and reptiles of conservation concern in Massachusetts is a difficult task, for several reasons:

- Vernal pool amphibians are often underground for the majority of the year, as is the Eastern Wormsnake.
- Most of these species use several habitat types over the course of their life span.
- The life history strategies of turtles and, to a certain extent, the snakes of concern are such that monitoring the viability of populations involves time- and resource-intensive efforts.
- Sea turtles do not nest in Massachusetts; their ocean movements are particularly difficult, in time and resources, to track.

Thus, several kinds of monitoring schemes must be set up to track reptiles and amphibians adequately.

1. Vernal Pool species, including Jefferson, Blue-spotted, Marbled, and Four-toed Salamanders; Eastern Spadefoots; and Spotted and Blanding's Turtles: Along with the ten-year cycle of monitoring vernal pools as a habitat, MassWildlife and its cooperators (PARC, volunteers, scientists from the University of Massachusetts) will target known sites of these vernal pool species and survey for them specifically, to determine presence/absence/non-detection at vernal pools and to assess population/breeding status.
2. Habitat generalists, including Spotted, Wood, and Blanding's Turtles; Eastern Ratsnakes; Black Racers; and Eastern Hognose Snakes: Monitoring these will involve more than monitoring the status of their habitats. At a minimum, MassWildlife and its cooperators will inventory known sites for these species every ten years, to determine presence/absence/non-detection. In addition, Mass Wildlife and its cooperators will, over the next ten years, determine the location of all populations and, especially, over-wintering dens, of these species in the state and, in the case of Black Racers and Eastern Hognose Snakes, establish a database to track known locations.
3. Species with long life spans, including all turtles and possibly the snakes: Here, MassWildlife and its cooperators will need to establish marked populations of these species, covering the range of small-to-large population numbers, urban-to-rural contexts, large-to-small available habitat acreage, etc., and monitor these marked individuals over long periods, probably a minimum of 20 years. In particular, Bog Turtles will be monitored. MassWildlife will work with PARC and other experts to determine how best to set up such long-term surveys.
4. Sea turtles: MassWildlife will cooperate and collaborate with all appropriate partners (USF&WS, MA Division of Marine Fisheries, NOAA, NMFA, New England Aquarium, MassAudubon, etc.) to develop a monitoring system targeted at sea turtles in Massachusetts waters.

As for the other herp species of concern, MassWildlife will work with PARC, the University of Massachusetts, and other cooperators to develop appropriate monitoring for Spring Salamanders, Northern Leopard Frogs, Eastern Wormsnake, and Eastern Ribbon Snake.

## **Birds**

The outline that follows presents recommendations for the most important avian monitoring projects in which MassWildlife and its partners should be involved during the next ten years. The intent of this outline is to help guide, expand, and prioritize MassWildlife's bird

conservation efforts and the funding and staff time that are allocated to them, especially in light of the growing number of planning efforts and bird conservation initiatives that are taking place at state, regional, and national levels, the growing expectations of our cooperators and constituents, and the evolving opportunities for funding and federal reimbursement associated with development and implementation of state comprehensive wildlife conservation strategies by state fish and wildlife agencies.

Projects are listed in roughly descending order of priority, based primarily on:

- 1) Massachusetts' importance relative to conservation efforts for various taxa and habitat types at regional and continental scales, and
- 2) listing status of species pursuant to the Massachusetts Endangered Species Act. Some projects comprise multiple sub-projects.

The Massachusetts Natural Heritage & Endangered Species Program (NHESP) will play a significant role in all of the projects and subprojects described in this document, in one or more of the following areas: development and implementation of monitoring programs; site-specific population or habitat protection and management; data compilation, quality checking, and reporting; maintenance of NHESP databases; regulatory protection; and technical assistance to cooperators. Various aspects of these projects will be carried out by MassWildlife and cooperators from other state and federal agencies, municipalities, private conservation groups, university researchers, and others, as is the case now. In some instances, MassWildlife contracts with outside cooperators may be the most effective way to accomplish priority tasks.

## **I. Coastal Waterbirds**

### **A. Beach-nesting birds**

- Target Species of Greatest Conservation Need: Piping Plover, Common Tern, Least Tern, American Oystercatcher

Tasks:

1. Monitor abundance, distribution, reproductive success, limiting factors, and effects of management at all breeding sites in Massachusetts (n = 125+ sites).
  - a. Coordinate annual statewide population monitoring.
  - b. Provide technical assistance to cooperators on monitoring protocols.
  - c. Compile, quality-check, and report statewide monitoring data.
  - d. Update NHESP databases.
  - e. Prepare and distribute technical reports and publications.
  - f. Host annual meeting of Massachusetts' coastal waterbird cooperators.
  - g. For Least Terns, evaluate current methods and metrics for estimating abundance, and develop methodologies for estimating annual reproductive success.
2. Protect populations and habitats at all breeding sites in Massachusetts.
  - a. Use state regulatory tools to protect birds, nests, and chicks from disturbance and direct mortality caused by pedestrian beach-goers, off-road vehicles, and pets, and to protect breeding and migration habitat from degradation caused by coastal development projects and off-road vehicles.
  - b. Update and modify regulatory polygons as necessary, based on data from annual monitoring. Identify and map marine habitats for Least Terns.

- c. Provide technical assistance to town and county governments, private landowners, and non-governmental organizations on management and regulatory issues.
- d. Develop and implement more effective predator management strategies.
  1. Provide increased technical assistance to managers in use of both lethal and non-lethal predator management techniques
  2. Contract with USDA Wildlife Services staff to carry out predator management at strategically important nesting sites.

## **B. Island-nesting terns and Laughing Gulls**

- Target Species of Greatest Conservation Need: Roseate Tern, Common Tern, Arctic Tern, Laughing Gull

### **Tasks:**

1. Monitor abundance, distribution, limiting factors, and effects of management at all breeding sites in Massachusetts.
  - a. Coordinate annual statewide census.
  - b. Provide technical assistance to cooperators on monitoring protocols.
  - c. Compile, quality-check, and report statewide census data.
  - d. Update NHESP databases.
  - e. Prepare and distribute technical reports and publications.
2. Protect populations and habitats at all breeding sites in Mass.
  - a. Use state regulatory tools to protect birds, nests, and chicks from disturbance and direct mortality caused by pedestrian beach-goers, ORVS, and pets, and to prevent degradation of breeding and migration habitat caused by coastal development projects and off-road vehicles.
  - b. Update and modify regulatory polygons as needed, based on results of annual monitoring and special projects (see # 7 below).
  - c. Provide technical assistance to municipal and county agencies, private landowners, and non-governmental organizations on management and regulatory issues.
  - d. Undertake predator management at priority sites using either non-lethal (e.g., electric fencing) or lethal (shooting, trapping) to reduce impacts of predation on adults, eggs, and chicks.
3. Continue Buzzards Bay tern restoration projects at Bird, Ram, and Penikese islands, including full-time seasonal staffing of islands to maintain predator-free breeding habitat; monitor abundance and reproductive success, and conduct population studies.
4. Restore tern colonies at Plymouth Long Beach (Common Tern, Least Tern).
5. Identify other suitable and strategically important sites where tern colonies should be restored. Plan and implement restoration projects.
6. Develop and implement protocols to derive indices of reproductive success at priority sites.
7. Identify and map marine habitats used for feeding and travel by Common and Roseate Terns. Use data to update regulatory polygons.

## **C. Migratory shorebirds**

- Target Species of Greatest Conservation Need: Ruddy Turnstone, Sanderling, Red Knot, Short-billed Dowitcher, Eskimo Curlew, Whimbrel

- Other targeted species: Semipalmated Sandpiper, Semipalmated Plover, Black-bellied Plover

Tasks:

1. Expand existing monitoring efforts by cooperators to provide information on distribution and relative abundance, indices to trends in abundance, and threats and management needs at priority sites.
2. Increase work with beach managers and landowners to protect migrating shorebirds and their habitats from disturbance and physical degradation of habitat using methods already in place to protect beach-nesting birds and their habitats.
3. Work with cooperators to develop protocols that maximize power and efficiency of monitoring to detect trends in abundance and distribution of priority species in Massachusetts.
4. Collaborate with Manomet Center for Conservation Science to develop NHESP shorebird database for use in site-specific management and regulatory protection.

#### **D. Breeding colonial waterbirds**

- Target Species of Greatest Conservation Need: Leach's Storm-Petrel, Snowy Egret, Black-crowned Night-Heron
- Other targeted species: Greater Black-backed Gull, Herring Gull, Double-crested Cormorant, Glossy Ibis, Great Egret

Tasks:

1. Coordinate/conduct periodic standardized statewide censuses of breeding colonial waterbirds in order to monitor trends in abundance and distribution.
2. Develop strategies and protocols to allow monitoring of highest priority species at priority sites every 3-5 years (e.g., consider use of sub-sampling, aerial imagery).
3. Increase standardization of census protocols for colonial waterbirds.
4. Conduct research in support of conducting more frequent and efficient monitoring, including estimating detection probabilities for various count methods, sub-sampling of breeding sites, use of aerial imagery as a partial replacement for ground counts and to inform sampling design; assessment of precision and accuracy of boat-based versus ground counts of gulls and cormorants on "small" islands.

#### **E. Non-breeding coastal waterbirds**

- Target Species of Greatest Conservation Need: Common Loon, Long-tailed Duck, Harlequin Duck, Common Eider
- Other targeted species: Horned Grebe, Greater Shearwater, Sooty Shearwater, Northern Gannet, Surf Scoter, White-winged Scoter, Black Scoter, Common Goldeneye, Bufflehead, Red-breasted Merganser, Bonaparte's Gull, Dovekie, Common Murre, Razorbill

Tasks:

1. Undertake baseline surveys to characterize and map distribution, relative abundance, and seasonal occurrence patterns of coastal waterbirds in Massachusetts' marine waters during non-breeding periods, i.e., during winter and both spring and fall migration.

## **II. Salt Marsh Birds**

- Target Species of Greatest Conservation Need: Saltmarsh Sharp-tailed Sparrow, Seaside Sparrow
- Other targeted species: Willet

Tasks:

1. Develop standardized protocols for, and conduct, field surveys to gather comprehensive, up-to-date baseline data on abundance and distribution of salt marsh sparrows. Collect abundance and distribution data for other salt marsh birds, including Willet, Clapper Rail, herons, egrets, and ibises, incidental to sparrow data.
2. Establish and maintain database on abundance, distribution, and habitat conditions for Saltmarsh Sharp-tailed Sparrows and Seaside Sparrows.
3. Establish long-term population monitoring program to track trends in abundance and distribution of priority species.
4. Identify and manage any threats to local populations and habitats.
5. Use regulatory tools to maintain current habitat base for salt marsh sparrows and Willets.

### **III. Grassland Birds**

- Target Species of Greatest Conservation Need: Upland Sandpiper, Barn Owl, Short-eared Owl, Vesper Sparrow, Grasshopper Sparrow, Henslow's Sparrow, American Kestrel, Eastern Meadowlark
- Other targeted species: Killdeer, Horned Lark, Bobolink, Savannah Sparrow

Tasks:

1. Monitor populations and habitat conditions for Upland Sandpipers and Grasshopper Sparrows every two to three years at key sites, e.g., Westover Air Reserve Base, Camp Edwards, Barnes Airport, Crane Wildlife Management Area, Nashawena Island.
2. Monitor populations and habitat conditions at secondary sites every three to five years.
3. Update NHESP databases as new data become available.
4. Use regulatory tools to protect, maintain, and enhance habitats at all current breeding sites. Update regulatory polygons as new data are available.
5. Provide technical assistance to cooperators on standardized census and reporting protocols.
6. Support/fund projects to conduct monitoring and habitat management at priority sites. Provide technical assistance to cooperators on management practices to optimize habitat conditions for target species.
7. Monitor trends in other species, especially American Kestrel, Killdeer, Horned Lark, Eastern Meadowlark, Bobolink, and Savannah Sparrow, through both standardized counts conducted as part of rare grassland bird surveys, and by achieving complete, annual in-state coverage of Breeding Bird Survey (BBS) routes. Determine which BBS routes are under-surveyed, and develop strategies to have them run each year. Work with the United States Geologic Survey and the Massachusetts Audubon Society to determine if some routes need to be replaced, i.e., where increased traffic volumes and noise since 1966 have rendered them untenable.

### **IV. Freshwater Marsh Birds**

- Target Species of Greatest Conservation Need: Pied-billed Grebe, American Bittern, Least Bittern, King Rail, Common Moorhen, Sedge Wren, Sora, Green Heron
- Other target species: Marsh Wren

Tasks:

1. Monitor abundance, distribution, and habitat status of priority species.
  - a. Survey  $n \geq 50$  wetlands statewide annually (combination of known, priority sites, and stratified random sample of sites with suitable habitat). Use standardized playback surveys to increase detection probabilities and, hence, efficiency of surveys.
  - b. Solicit "presence" data for priority species during the breeding season from reliable birders and biologists.
  - c. Provide technical assistance to cooperators on standardized monitoring and site-selection protocols.
2. Map habitats and develop conservation plans for sites where priority species occur. Conduct targeted surveys to gather "home range" data for priority species at key sites to inform regulatory mapping. Identify and map both wetland and adjacent upland habitats that will benefit target species through acquisition or regulatory protection. Where appropriate, develop protocols for controlling invasive plants.
3. Update NHESP database and regulatory polygons using data generated via Tasks 1 and 2 above.

## V. State-listed Raptors

- Target Species of Greatest Conservation Need: Bald Eagle, Northern Harrier, Sharp-shinned Hawk, Peregrine Falcon, Barn Owl, Long-eared Owl, Short-eared Owl

Tasks:

1. Annually monitor distribution, abundance, and reproductive success of breeding Peregrine Falcons and Bald Eagles.
2. Update nesting or home range locations of breeding Northern Harriers and Short-eared Owls every 3-5 years.
3. Update NHESP database and regulatory polygons based on data generated by tasks 1 and 2 above.

## VI. Common Loon

- Target Species of Greatest Conservation Need: Common Loon

Tasks:

1. Monitor distribution, abundance, and reproductive success annually at all breeding sites.
  - a. Coordinate annual statewide census of abundance and distribution of breeding birds. Solicit standardized information on nesting chronology and reproductive success.
  - b. Provide technical assistance to cooperators on monitoring protocols.
  - c. Compile, quality check, and report statewide census data.
  - d. Update NHESP databases
2. Protect birds and habitats at all breeding sites in Massachusetts.
  - a. Use state regulatory tools to protect adults, nests and chicks from human-caused disturbance and direct mortality and to prevent habitat degradation.



- b. Update and modify regulatory polygons as needed based on results of annual monitoring.
- c. Provide technical assistance to landowners and land managers on regulatory and management issues.
- d. Install and maintain nesting rafts where appropriate to enhance breeding habitat.

## **VII. Nightjars (Goatsuckers)**

- Target Species of Greatest Conservation Need: Whip-poor-will
- Other targeted species: Common Nighthawk

### **Tasks:**

1. Undertake statewide, standardized surveys and solicit breeding season reports from birders in order to assess distribution patterns within Massachusetts (i.e., determine habitats and/or geographic areas in which to focus census, management, land protection, and research efforts).
2. Participate in regional efforts to develop and implement long-term population monitoring, using standardized methodologies that maximize power and efficiency.
3. Develop habitat management recommendations and implement them on DFW lands.
4. Provide technical assistance to cooperators on habitat management practices to benefit breeding Whip-poor-wills and Common Nighthawks.

## **VII. Shrubland Birds**

- Target Species of Greatest Conservation Need: Golden-winged Warbler, Mourning Warbler, Northern Bobwhite, Prairie Warbler, Willow Flycatcher, Eastern Towhee, American Woodcock, Field Sparrow, Brown Thrasher, Blue-winged Warbler

### **Tasks:**

1. Monitor long-term trends in relatively common species by annually achieving maximum coverage of Breeding Bird Survey (BBS) routes statewide (n=26 routes), as the most effective and efficient means of monitoring population trends in the largest number of relatively common species. Determine which BBS routes are under-surveyed, and develop strategies to have them run each year. Work with USGS and MassAudubon to determine if some routes need to be replaced, i.e., where increased traffic volumes and noise since 1966 have rendered them untenable.
2. Draft guidelines/recommendations for creating/managing shrubland habitats and distribute to state landowners/managers and other cooperators.
3. To obtain an index of the spring breeding population of the American Woodcock, conduct an annual randomized spring woodcock singing ground surveys in cooperation with the U.S. Fish and Wildlife Service.
4. Conduct a biennial Northern Bobwhite whistle count survey during the first two weeks of July, using established procedures from roadside routes to determine the dynamic aspects of Northern Bobwhite population densities and distribution.

## **VIII. Forest Birds**

- Target Species of Greatest Conservation Need: Sharp-shinned Hawk, Long-eared Owl, Northern Parula, Blackpoll Warbler, Ruffed Grouse, Broad-winged Hawk, Wood Thrush, Louisiana Waterthrush, Canada Warbler, White-throated Sparrow

### **Tasks:**

1. Monitor long-term trends in relatively common species by achieving annual maximum coverage of Breeding Bird Survey (BBS) routes statewide (n =26 routes), as the most effective and efficient means of monitoring population trends in the largest number of relatively common landbird species. Determine which BBS routes are under-surveyed, and develop strategies to have them run each year. Work with USGS and MassAudubon to determine if some routes need to be replaced, i.e., where increased traffic volumes and noise since 1966 have rendered them untenable.
2. Conduct Ruffed Grouse drumming counts, by DFW staff and volunteers, at 29 random secondary roadside routes.
3. Conduct a 3- to 5-year statewide, landscape-based density study to obtain statistically reliable density estimates for Ruffed Grouse in Massachusetts, while comparing densities within the two major ecological provinces in the state (Northern Hardwood vs. Eastern Broadleaf). This data will help to further provide population estimates for ruffed grouse statewide. The study has received support in cooperation with the USGS Cooperative Research Unit in Amherst, MA.

## **IX. Inland Waterfowl**

- Target Species of Greatest Conservation Need: American Black Duck
- Other targeted species: Mallard, Wood Duck, Canada Goose

### **Tasks:**

1. Waterfowl Production Survey: Conduct annual breeding plot survey of American Black Duck, Mallard, Wood Duck, and Canada Goose in Massachusetts to obtain reliable annual estimates of waterfowl production in the Atlantic Flyway.
2. Coastal and Inland Waterfowl Banding: Band 1,000 ducks annually, targeting American Black Ducks, Wood Ducks and Mallards, though other species are banded as encountered, to determine recovery and survival rates for these species and provide information on movements and wintering areas for species.

## **Mammals**

Three game mammals (Bobcat, New England Cottontail, Black Bear) are adequately monitored by on-going surveys of harvested animals. In addition, Black Bear cub production and survival continues to be monitored by MassWildlife staff. Moose populations are expanding in Massachusetts and surveys are being developed by MassWildlife to monitor their populations over the long term and to assess moose population ecology in suburban areas.

Specific programs for monitoring Black Bear include the following:

- **Black Bear Distribution and Harvest Investigations**  
Data is collected on the annual harvest, hunter characteristics and demographics, and sex and age ratios. Nuisance and damage complaints are summarized and reported. The evaluation is conducted through district field offices and monitored by the agency's Black Bear project leader and is used to refine the range, demographics, and activities of Black Bear in Massachusetts.
- **Black Bear Productivity and Cub Survival**  
A sample of radio-collared black bears has been maintained in western Massachusetts, principally in the Connecticut Valley region, since 1980. Capture, radio-tagging, and

monitoring of female black bears has been critical in evaluating cub production and survival, and hence to address changes in bear demography in Massachusetts. This investigation has been principally conducted by the Division of Fisheries & Wildlife, but has received research support through the years in cooperation with the USGS Cooperative Research Unit and the University of Massachusetts.

Specific programs for monitoring Moose include the following:

- **Moose Sighting Surveys**  
Baseline indices are being developed for the moose population in Massachusetts. The deer hunter survey has been used to determine a statewide moose sighting of 0.24 moose/100 hours of deer hunting. A presence-absence block survey was conducted for the first time in 2004 with volunteers from the University of Massachusetts to help define and develop a possible statewide survey for moose sign. The objective of these surveys is to: (1) develop a repeatable, quantitative index to low-density moose populations, (2) develop a survey protocol for long-term monitoring of moose, and (3) determine an appropriate design and sampling intensity for applying an index to monitor the status of the moose population in Massachusetts.
- **Suburban Moose Population Ecology**  
Moose are present and established in Massachusetts, and all trend data (moose-vehicle accidents, moose destroyed or immobilized and moved for public safety reasons) indicate an increasing moose population in the state. However, because of the continuing fragmentation and development of the landscape, a species with such large home-range could be threatened. Currently, DFW biologists in cooperation with the USGS Cooperative Research Unit, the Massachusetts Environmental Police, and the University of Massachusetts are capturing and collaring moose with Global Positioning System (GPS) collars. These GPS collars can collect and store exact locations of the collared animal over a specific time period, providing more and better data than conventional VHF telemetry devices. Using this approach, the objective is to capture up to 10 moose per year for three to five years and fit them with store-on-board GPS collars. Through GPS technology, data is being collected concerning moose habitat use, movement patterns across the landscape, survival rates, and cause-specific mortality. This research will form the basis of a regional study that will be critical to conserving the moose populations at the southern fringe of their historic range in a landscape fragmented by an extensive road system and suburban-urban development.

Specific programs for monitoring Bobcat include the following:

- **Bobcat Harvest Evaluation**  
Data is collected on the annual harvest, hunter characteristics, demographics of the bobcat season, sex and age ratios and reproductive condition of bobcats. This includes data from hunting, trapping, and salvaged roadkills. The evaluation is conducted through district field offices and monitored by the agency's furbearer project leader.

Regional Inventory of New England Cottontails

- The Massachusetts Division of Fisheries & Wildlife supported a regional inventory of New England Cottontails being conducted by John A. Litvaitis and associates with the

Department of Natural Resources of the University of New Hampshire. The objectives of the regional inventory were to: (1) survey the historic range of the New England Cottontail to determine the proportion currently occupied; (2) identify population centers where rabbit abundance is sufficient to withstand short-term perturbations and serve as sources for possible translocations; and (3) identify high-priority sites to establish new populations. The interim progress report submitted to DFW in October 2003 provided: (1) a summary of the current distribution of New England Cottontails, including maps that summarized occupied and potential habitats on a county basis; and (2) a step-by-step summary of monitoring protocols. Further, the final report also detailed recommendations for expanding local populations of New England Cottontail by implementing habitat manipulations. MassWildlife will continue to survey the current range of New England Cottontail on a five-year cycle, will begin habitat manipulations aimed at expanding New England Cottontail populations, and will monitor the results of those manipulations, adjusting future actions accordingly.

Bat hibernacula are monitored by MassWildlife staff approximately every ten years. These surveys monitor only two of the five bat species of conservation concern (Indiana Myotis and Eastern Small-footed Bat), as the others (Silver-haired Bat, Eastern Red Bat, and Hoary Bat) do not hibernate in Massachusetts. There are no monitoring programs in place for the latter three bats. MassWildlife plans to develop monitoring programs for migratory bats, in cooperation with other conservation partners.

Data on state-listed small mammals (Water Shrew, Rock Shrew, and Southern Bog Lemming) is collected occasionally by MassWildlife staff and other biologists and naturalists, and added to the Natural Heritage & Endangered Species Program database. There is no monitoring program in place for Beach Vole currently; this species will be addressed in the future in cooperation with other conservation partners.

Although Sperm, Fin, Sei, Blue, Humpback, and Northern Right Whales are state-listed, data on their locations are not kept by the Natural Heritage and Endangered Species Program. There is no monitoring program in place for Harbor Porpoise. MassWildlife will cooperate and collaborate with all appropriate partners (USF&WS, MA Division of Marine Fisheries, NOAA, NMFS, New England Aquarium, MassAudubon, etc.) to incorporate their monitoring data for marine mammals in Massachusetts waters.

#### **Miscellaneous Invertebrates, Snails, Freshwater Mussels, Crustaceans, and Beetles**

There are no monitoring programs in place for these invertebrates, except for some of the beetles and occasional Rare Species Database additions for the other species. MassWildlife intends to investigate the feasibility of monitoring individual high-priority invertebrate species, or groups/guilds of high-priority species, as part of our conservation plan.

One possibility would be to determine the presence/absence of previously documented miscellaneous invertebrates of concern on a rotating ten-year survey and monitoring program, as shown in the table below. This proposed program focuses on different major invertebrate habitats; several species can be surveyed for at each site.

**Table 6. Schedule of Monitoring Miscellaneous Invertebrates, Snails, Freshwater Mussels, Crustaceans, and Beetles**

<b>Invertebrate Habitats</b>	<b>Years 1-2</b>	<b>Years 3-4</b>	<b>Years 5-6</b>	<b>Years 7-8</b>	<b>Years 9-10</b>
Connecticut & Merrimack River mainstems	X				
Other rivers and streams		X			
Coastal Plain Ponds			X		
Uplands				X	
Other habitats and missed occurrences					X

Table 7 below notes which invertebrates of concern would be monitored by surveys in each of the major habitats above.

**Table 7. Miscellaneous Invertebrate Habitat Surveys**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Connecticut &amp; Merrimack River mainstems</b>	<b>Other rivers &amp; streams</b>	<b>Coastal Plain Ponds</b>	<b>Uplands</b>	<b>Other habitats &amp; missed occurrences</b>
<i>Spongilla aspinosa</i>	Smooth Branched Sponge					X
<i>Corvomeyenina everetti</i>	Mount Everett Pond Sponge					X
<i>Polycelis remota</i>	Sunderland Spring Planarian					X
<i>Macrobdella sesteria</i>	New England Medicinal Leech					X
<i>Alloperla voinae</i>	A Stonefly		X			
<i>Hansonoperla appalachia</i>	Hanson's Appalachian Stonefly		X			
<i>Perlesta nitida</i>	A Stonefly		X			
<i>Cincinnatia winkleyi</i>	New England Siltsnail					X
<i>Ferrissia walkeri</i>	Walker's Limpet					X
<i>Littoridinops tenuipes</i>	Coastal Marsh Snail					X
<i>Pomatiopsis lapidaria</i>	Slender Walker		X			

Scientific Name	Common Name	Connecticut & Merrimack River mainstems	Other rivers & streams	Coastal Plain Ponds	Uplands	Other habitats & missed occurrences
<i>Pyrgulopsis lustrica</i>	Pilsbry's Spire Snail					X
<i>Valvata sincera</i>	Boreal Turret Snail					X
<i>Vertigo perryi</i>	Olive Vertigo					X
<i>Physa vernalis</i>	Vernal Physa					X
<i>Alasmodonta heterodon</i>	Dwarf Wedgemussel		X			
<i>Alasmodonta undulata</i>	Triangle Floater		X			
<i>Alasmodonta varicosa</i>	Brook Floater		X			
<i>Lampsilis cariosa</i>	Yellow Lampmussel	X				
<i>Leptodea ochracea</i>	Tidewater Mucket	X		X		X
<i>Ligumia nasuta</i>	Eastern Pondmussel			X		X
<i>Strophitus undulatus</i>	Creeper		X			X
<i>Cambarus bartonii</i>	Appalachian Brook Crayfish		X			
<i>Eubrachyus intricatus</i>	Intricate Fairy Shrimp					X
<i>Eulimnadia agassizii</i>	Agassiz's Clam Shrimp					X
<i>Gammarus pseudolimnaeus</i>	Northern Spring Amphipod					X
<i>Limnadia lenticularis</i>	American Clam Shrimp					X
<i>Stygobromus borealis</i>	Taconic Cave Amphipod					X
<i>Stygobromus tenuis tenuis</i>	Piedmont Groundwater Amphipod					X
<i>Synurella chamberlaini</i>	Coastal Swamp Amphipod					X
<i>Caenestheriella gynecia</i>	Feminine Clam Shrimp					X
<i>Cicindela duodecimguttata</i>	Twelve-Spotted Tiger Beetle				X	
<i>Cicindela rufiventris hentzii</i>	Hentz's Redbelly Tiger Beetle				X	
<i>Cicindela dorsalis dorsalis</i>	Northeastern Beach Tiger Beetle				X	
<i>Cicindela limbalis</i>	Bank Tiger Beetle				X	
<i>Cicindela marginipennis</i>	Cobblestone Tiger Beetle	X				
<i>Cicindela patruela</i>	Barrens Tiger Beetle				X	
<i>Cicindela puritana</i>	Puritan Tiger Beetle	X				
<i>Cicindela purpurea</i>	Purple Tiger Beetle				X	
<i>Nicrophorus americanus</i>	American Burying Beetle				X	

Scientific Name	Common Name	Connecticut & Merrimack River mainstems	Other rivers & streams	Coastal Plain Ponds	Uplands	Other habitats & missed occurrences
<i>Hygrotus sylvanus</i>	Sylvan Hygrotus Diving Beetle					X

### Dragonflies and Damselflies

There are no monitoring programs in place for these invertebrates, except for occasional Rare Species Database additions or targeted surveys for specific species and/or sites. We intend to investigate the feasibility of monitoring individual high-priority odonate species, or groups/guilds of high-priority species, as part of our conservation plan.

One possibility would be to determine the presence/absence of previously documented Odonata of concern on a rotating ten-year survey and monitoring program, as shown in the table below. This proposed program focuses on different major odonate habitats; several species can be surveyed for at each site.

**Table 8. Schedule of Monitoring Dragonflies and Damselflies**

Odonata Habitats	Years 1-2	Years 3-4	Years 5-6	Years 7-8	Years 9-10
Connecticut & Merrimack River mainstems	X				
Other rivers and streams		X			
Bogs and peatlands			X		
Coastal Plain Ponds				X	
Other habitats and missed occurrences					X

Table 9, below, notes which odonates of concern would be monitored by surveys in each of the major habitats listed above.

**Table 9. Dragonfly and Damselfly Habitat Surveys**

Scientific Name	Common Name	Connecticut & Merrimack River mainstems	Other rivers & streams	Bogs and peatlands	Coastal Plain Ponds	Other habitats & missed occurrences
<i>Aeshna mutata</i>	Spatterdock Darner			X		
<i>Aeshna subarctica</i>	Subarctic Darner			X		
<i>Anax longipes</i>	Comet Darner				X	
<i>Boyeria grafiana</i>	Ocellated Darner		X			
<i>Gomphus abbreviatus</i>	Spine-Crowned Clubtail	X	X			

Scientific Name	Common Name	Connecticut & Merrimack River mainstems	Other rivers & streams	Bogs and peatlands	Coastal Plain Ponds	Other habitats & missed occurrences
<i>Gomphus descriptus</i>	Harpoon Clubtail		X			
<i>Gomphus fraternus</i>	Midland Clubtail	X				
<i>Gomphus quadricolor</i>	Rapids Clubtail	X	X			
<i>Gomphus vastus</i>	Cobra Clubtail	X				
<i>Gomphus ventricosus</i>	Skillet Clubtail		X			
<i>Neurocordulia obsoleta</i>	Umber Shadowdragon		X			X
<i>Neurocordulia yamaskanensis</i>	Stygian Shadowdragon	X	X			
<i>Ophiogomphus aspersus</i>	Brook Snaketail		X			
<i>Ophiogomphus carolus</i>	Riffle Snaketail		X			
<i>Somatochlora elongata</i>	Ski-Tailed Emerald		X			
<i>Somatochlora forcipata</i>	Forcipate Emerald		X	X		
<i>Somatochlora georgiana</i>	Coppery Emerald		X			
<i>Somatochlora incurvata</i>	Incurvate Emerald			X		
<i>Somatochlora kennedyi</i>	Kennedy's Emerald		X			X
<i>Somatochlora linearis</i>	Mocha Emerald		X			
<i>Stylurus amnicola</i>	Riverine Clubtail	X				
<i>Stylurus scudderi</i>	Zebra Clubtail		X			
<i>Stylurus spiniceps</i>	Arrow Clubtail	X	X			
<i>Williamsonia fletcheri</i>	Ebony Boghaunter			X		
<i>Williamsonia lintneri</i>	Ringed Boghaunter			X		
<i>Enallagma carunculatum</i>	Tule Bluet					X
<i>Enallagma daeckii</i>	Attenuated Bluet					X
<i>Enallagma laterale</i>	New England Bluet				X	X
<i>Enallagma pictum</i>	Scarlet Bluet				X	
<i>Enallagma recurvatum</i>	Pine Barrens Bluet				X	
<i>Enallagma minusculum</i>	Little Bluet				X	X

### Moths and Butterflies

There are no monitoring programs in place for these invertebrates, except for occasional Rare Species Database additions or targeted surveys for specific species and/or sites. We intend to



investigate the feasibility of monitoring individual high-priority Lepidoptera species, or groups/guilds of high-priority species, as part of our conservation plan.

One possibility would be to determine the presence/absence of previously documented moths and butterflies of concern on a rotating ten-year survey and monitoring program, as shown in the table below. This proposed program focuses on different major moth and butterfly habitats; several species can be surveyed for at each site.

**Table 10. Schedule of Monitoring Butterflies and Moths**

<b>Lepidoptera Habitats</b>	<b>Years 1-2</b>	<b>Years 3-4</b>	<b>Years 5-6</b>	<b>Years 7-8</b>	<b>Years 9-10</b>
Pitch Pine/Scrub Oak, southeast MA	X				
Pitch Pine/Scrub Oak, rest of MA		X			
Wetland habitats			X		
Upland Forests				X	
Other habitats and missed occurrences					X

Table 11 below notes which Lepidoptera of concern would be monitored by surveys in each of the major habitats above.

**Table 11. Butterfly and Moth Habitat Surveys**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Pitch Pine/Scrub Oak, SE MA</b>	<b>Pitch Pine/Scrub Oak, rest of MA</b>	<b>Wetland habitats</b>	<b>Upland Forests</b>	<b>Other habitats &amp; missed occurrences</b>
<i>Abagrotis nefascia</i>	Coastal Heathland Cutworm	X				X
<i>Acronicta albarufa</i>	Barrens Daggermoth	X				
<i>Anisota stigma</i>	Spiny Oakworm	X				
<i>Apamea inebriata</i>	Drunk Apamea Moth			X		
<i>Apamea mixta</i>	Coastal Plain Apamea Moth			X		
<i>Apodrepanulatrix liberaria</i>	New Jersey Tea Inchworm		X			X
<i>Bagisara rectifascia</i>	Straight Lined Mallow Moth	X		X		X
<i>Callophrys hesseli</i>	Hessel's Hairstreak			X		
<i>Callophrys irus</i>	Frosted Elfin	X				X
<i>Callophrys lanoraieensis</i>	Bog Elfin			X		
<i>Catocala herodias gerhardi</i>	Gerhard's Underwing	X	X			
<i>Catocala pretiosa pretiosa</i>	Precious Underwing Moth			X		

Scientific Name	Common Name	Pitch Pine/ Scrub Oak, SE MA	Pitch Pine/ Scrub Oak, rest of MA	Wetland habitats	Upland Forests	Other habitats & missed occurrences
<i>Chaetagnathaea cerata</i>	Waxed Sallow Moth	X				X
<i>Cicinnus melsheimeri</i>	Melsheimer's Sack Bearer	X				
<i>Cingilia catenaria</i>	Chain Dot Geometer	X		X		X
<i>Cynia inopinatus</i>	Unexpected Cynia					X
<i>Digrammia eremiata</i>	Three-lined Angle Moth					X
<i>Eacles imperialis</i>	Imperial Moth	X				
<i>Erora laeta</i>	Early Hairstreak				X	
<i>Erynnis persius persius</i>	Persius Duskywing	X				X
<i>Euchlaena madusaria</i>	Sandplain Euchlaena					X
<i>Euphyes dion</i>	Dion Skipper			X		
<i>Faronta rubripennis</i>	The Pink Streak					X
<i>Grammia phyllira</i>	Phyllira Tiger Moth					X
<i>Hemaris gracilis</i>	Slender Clearwing Sphinx Moth	X	X	X		X
<i>Hemileuca maia</i>	Barrens Buckmoth	X	X			X
<i>Hypomecis buchholzaria</i>	Buchholz's Gray	X				
<i>Itame</i> sp. 1	Pine Barrens Itame	X	X			
<i>Lithophane viridipallens</i>	Pale Green Pinion Moth			X		
<i>Lycia rachelae</i>	Twilight Moth		X			
<i>Lycia ypsilon</i>	Pine Barrens Lycia	X				
<i>Metarranthis apiciaria</i>	Barrens Metarranthis	X				
<i>Metarranthis pilosaria</i>	Coastal Swamp Metarranthis			X		
<i>Neoligia semicana</i>	Northern Brocade Moth			X		
<i>Oncocnemis riparia</i>	Dune Noctuid Moth					X
<i>Papaipema appassioata</i>	Pitcher Plant Borer			X		
<i>Papaipema</i> sp. 2	Ostrich Fern Borer			X		
<i>Papaipema stenocelis</i>	Chain Fern Borer			X		
<i>Papaipema sulphurata</i>	Water-Willow Stem Borer			X		
<i>Pieris oleracea</i>	Eastern Veined White				X	
<i>Psectraglaea carnosia</i>	Pink Sallow Moth	X	X			

Scientific Name	Common Name	Pitch Pine/ Scrub Oak, SE MA	Pitch Pine/ Scrub Oak, rest of MA	Wetland habitats	Upland Forests	Other habitats & missed occurrences
<i>Ptichodis bistrigata</i>	Southern Ptichodis	X				
<i>Rhodoecia aurantiago</i>	Orange Sallow Moth				X	
<i>Satyrrium favonius</i>	Oak Hairstreak				X	
<i>Spartiniphaga inops</i>	Spartina Borer			X		
<i>Stenoporpia polygrammaria</i>	Faded Gray Geometer	X				
<i>Zale</i> sp. 1	Pine Barrens Zale	X	X			
<i>Zanclognatha martha</i>	Pine Barrens Zanclognatha	X	X			
<i>Hadena ectypa</i>	Appalachian Coronet				X	
<i>Macrochilo bivittata</i>	Two-striped Cord Grass Moth			X		
<i>Pieris virginienensis</i>	West Virginia White				X	
<i>Schizura apicalis</i>	Plain Schizura	X	X			
<i>Zale curema</i>	Northeastern Pine Zale	X				

## Monitoring by Habitat

### Large-scale Habitats

Monitoring the Connecticut and Merrimack River mainstems and Large and Mid-sized Rivers will largely consist of continuing the current water quality surveys conducted by the Massachusetts Department of Environmental Protection (DEP). For Marine and Estuarine Habitats, the Office of Coastal Zone Management will continue the following monitoring projects:

- Marine invasive species;
- Eelgrass beds;
- Sea floor mapping; and
- Salt marshes.

MassWildlife will work with DEP, Coastal Zone Management, and the Division of Marine Fisheries to develop additional monitoring protocols.

On the other hand, monitoring Upland Forests, Large Unfragmented Landscape Mosaics, and Pitch Pine/Scrub Oak will consist of constructing workable definitions of these habitat types, mapping the extent of the habitat on current aerial photographs of the state, and updating and analyzing changes in the habitats every ten years (or when new aerials are available). This does not deal with the question of the condition of each habitat (invasion by exotic plants, species composition, etc.), but only compares the areal extent of each habitat over time and among different regions of the state. MassWildlife and its partners will investigate and develop methods of monitoring habitat condition for these three large-scale habitats.

### *Medium-scale Habitats*

The status of the nine medium-scale habitat types identified in this CWCS (Small Streams; Shrub Swamps; Forested Swamps; Lakes and Ponds; Salt Marsh; Coastal Dunes, Beaches, and Small Islands; Grasslands; Young Forests and Shrublands; and Riparian Forest) will be monitored over time by surveying a random, stratified sample of each habitat type according to the timetable below. Surveys of each sampled habitat will include presence/absence of the habitat; presence/absence/non-detection of associated species of greatest conservation need; habitat condition; and condition of landscape context, as well as other data as required.

Some of these medium-scale habitat types are relatively well-identified and well-studied in Massachusetts (e.g., Lakes and Ponds, Salt Marsh, and Grasslands), although there are some gaps in our knowledge. Because of the existing data and small size of these habitats, the status of these habitats can be monitored effectively by planned site visits.

However, most of these medium-scale habitats will need to be inventoried on a statewide basis, before long-term monitoring of their status can occur. Thus, the first steps in monitoring Small Streams; Shrub Swamps; Forested Swamps; Coastal Dunes, Beaches, and Small Islands; Young Forests and Shrublands; and Riparian Forest will be to define each habitat from a practical stance, to identify and map occurrences of each habitat statewide using current aerial photographs, and to ground-check what appear to be the best examples. Then these documented occurrences will be monitored by site visits as described above.

Monitoring these nine medium-scale habitats will be according to the schedule in the table below.

**Table 12. Schedule of Medium-Scale Habitat Monitoring**

<b>Habitat Type</b>	<b>Years 1-2</b>	<b>3-4</b>	<b>5-6</b>	<b>7-8</b>	<b>9-10</b>
Small Streams	X				
Shrub Swamps		X			
Forested Swamps		X			
Lakes & Ponds			X		
Salt Marsh				X	
Coastal Dunes, Beaches, & Small Islands				X	
Grasslands					X
Young Forests and Shrublands					X
Riparian Forest	X				

### *Small-scale Habitats*

The status of the seven small-scale habitat types identified in this CWCS (Vernal Pools; Coastal Plain Ponds; Springs, Caves & Mines; Peatlands & Associated Habitats; Marshes & Wet Meadows; Rocky Coastlines; and Rock Cliffs, Ridgetops, Talus Slopes, & Similar Habitats) will be monitored over time by surveying a random, stratified sample of each habitat type according to the timetable below. Surveys of each sampled habitat will include presence/absence of the

habitat; presence/absence/non-detection of associated species of greatest conservation need; habitat condition; and condition of landscape context, as well as other data as required.

Unlike large-scale and medium-scale habitats, described above, these small-scale habitats are relatively well identified in Massachusetts, although there are some gaps in our knowledge. Because of the existing data and small size of these habitats, the status of these habitats can be monitored effectively by planned site visits.

**Table 13. Schedule of Small-Scale Habitat Monitoring**

<b>Habitat Type</b>	<b>Years 1-2</b>	<b>3-4</b>	<b>5-6</b>	<b>7-8</b>	<b>9-10</b>
Vernal Pools	X				
Coastal Plain Ponds		X			
Springs, Caves & Mines			X		
Peatlands & Associated Habitats				X	
Marshes & Wet Meadows					X
Rocky Coastlines			X		
Rock Cliffs, Ridgetops, Talus Slopes, & Similar Habitats			X		

## B. Monitoring the Effectiveness of Conservation Actions

The protection of habitat is the most important step in protecting the biodiversity of the Commonwealth. Therefore, the overall success of implementing conservation actions will be measured by both the improved status for species of greatest conservation need (measured through the monitoring efforts described in Section A) and by increased acreages of key habitats protected. Specific measures of success for the actions to conserve habitats for species in greatest need of conservation are summarized in Chapter 7. These measures provide a means of assessing the effectiveness of individual conservation actions. For example, if the conservation action is to increase grassland habitat, then the measure would be to quantify the number of newly acquired grassland acres subject to proper grassland management. By using performance indicators, MassWildlife will track the implementation and effectiveness of the conservation actions discussed in the next chapter. Examples of performance measures for various conservation actions are shown in Table 14, based on Chapter 7. Massachusetts will use the annual performance report requirement for State Wildlife Grant (SWG) funded projects as a base for an annual assessment tool for monitoring the effectiveness of conservation actions. An annual summary will be prepared that describes conservation actions and performance indicators.

**Table 14. Performance Measures for Conservation Actions.**

<b>Conservation Action Category</b>	<b>Examples of Performance Measures</b>
Proactive Habitat Protection	Acreage of rare species habitat conserved Number of partnerships involved in land protection efforts Number of important habitats conserved

Conservation Action Category	Examples of Performance Measures
Surveys/Monitoring/Databases	Number of species surveyed Number of sites surveyed Percentage of monitoring plans completed
Conservation Planning	Number of conservation plans completed Percent of conservation plans partially or completely implemented
Environmental Regulation	Number of proposed alterations regulated Number of acres permanently conserved as a result of regulation Number of mitigation actions implemented
Habitat Restoration/Management	Number of acres burned in prescribed fires Number of partners involved in restoration efforts Percent increase in species targeted by management and restoration actions
Coordination/Partnerships	Number of partners involved in implementing the CWCS Number of projects involving collaboration
Education/Outreach	Number of presentations to citizen groups Number of outreach publications prepared Number of meetings with municipal boards

## C. Adaptive Management

Adaptive management is a tool routinely used in conservation management to continually improve species and habitat conservation activities by incorporating lessons learned from past successful and unsuccessful management efforts into future efforts. As information gaps identified in Chapter 9 are addressed, the status and condition of species and habitats will be updated. MassWildlife, the Natural Heritage & Endangered Species Advisory Committee, cooperators, and partners will regularly review conservation actions to determine if performance measures are being achieved or if new or adaptive management measures are needed. The effectiveness and adaptability of this CWCS will be measured by the frequency and degree of its use by MassWildlife's many programs, as well as those of cooperators and partners.

The proactive protection of the habitats of the species in greatest need of conservation is the most important conservation strategy in the Massachusetts Comprehensive Wildlife Conservation Strategy. As an example of adaptive management of this strategy, the following questions will be asked:

- What percentage of the occurrences of each rare species is protected?
- What are the “best” unprotected occurrences of each rare species?
- Of the “best” unprotected occurrences, which should be targeted for protection?

Chapter 7 considers this topic in more detail; the relevant points are repeated below.

1. **Knowledge of what land is protected in the Commonwealth, by whom, and for what purpose.** Massachusetts has a very good state GIS system, MassGIS, which constantly updates their data on protected open space, including ownership and purposes. However,

due to understaffing, the MassGIS program is often six months to a year behind in adding new state-owned conservation lands to their database. It has no systematic way to update newly protected lands acquired by municipalities or private non-profits. Both of these issues should be addressed. Since development is one of the greatest threats to wildlife in Massachusetts, more up to date landuse maps are needed. Without an accurate and relatively up-to-date database of what is already protected, we cannot plan for future acquisitions effectively and efficiently.

2. **Knowledge of the biological resources of the state, particularly of the species and habitats in greatest need of conservation.** Our knowledge of the statewide distribution of these species and habitats is uneven. For some species (for example, Federally listed species and fish species in general), there have been recent or on-going statewide surveys of all suitable habitat and, thus, our knowledge of their distribution and abundance in the state is relatively complete. MDFW has a comprehensive database of fish distribution and abundance for the fish species listed as in Greatest Need of Conservation. On the other hand, some state-listed species (for example, some aquatic macroinvertebrates) are just now receiving the kind of survey effort that will clarify their distribution and abundance; thus, we do not yet have sufficient knowledge of even all of the state-listed species. For non-listed species in greatest need of conservation, whether globally rare, game animals, or associated with early successional habitats, our state of knowledge is particularly insufficient. Likewise, for some habitats of concern – coastal plain ponds, bogs – we have recent field surveys, targeted at the best examples as identified by aerial photo-interpretation. For other habitats – large, unfragmented natural landscape mosaics – we are just beginning to realize the need for conservation and, frankly, have a difficult time identifying these habitats on the ground. Elsewhere in this Strategy, the details of these survey and inventory needs are covered; here it needs only be noted that this knowledge is absolutely essential for conservation of our biodiversity.
3. **Knowledge of which species and habitats are already protected.** As a consequence of completing the two elements above, it will be possible to clarify the level of protection afforded each of the species and habitats in greatest need of protection. Again, this analysis should be completed, not just for state-owned lands, but for all property owned and/or managed for conservation purposes across the Commonwealth. This element involves inventory and assessment of the biological resources supported in whole or in part by each parcel of protected land, to answer such questions as: What percentage of the occurrences of a SGNC species or habitat are on protected land? Which SGNC species or habitats are least well protected, currently?
4. **Prioritization of protection efforts.** This element involves making what can only be described as judgment calls. For example, all things being equal, what species should be targeted for immediate protection? It is easy to see that different conservationists might answer differently: protect all the occurrences of the very rare species first; or protect first the most viable populations of those species judged most likely to persist if properly conserved; protect first order streams, or protect wildlife corridors first; or protect large, contiguous landscapes of natural habitats first; or protect first what our human

constituency at large wants protected – the glamorous and showy rare species, the beautiful landscapes, and their favorite hunting and fishing spots.

In reality, future conservation efforts will involve numerous organizations and individuals; the MDFW is only one of the partners in the cause. Each organization and each scientist or conservationist will have their own priorities for protection, dictated by organization policies, funding sources, and personal preferences. However, with the BioMap and Living Waters projects, many conservation entities in Massachusetts have proven themselves eager to base their protection efforts on biological data, interpreted by knowledgeable scientists, and disseminated to usable formats.

It is a major goal of this Strategy to develop a consistent and objective prioritization system for habitat protection, aimed at the identified species and habitats in greatest need of conservation, with the input of as broad a spectrum of knowledgeable biologists as is feasible.

5. **Identification of land for protection, based on stated priorities.** Once priorities for land protection are established, these priorities should be applied to the existing knowledge of the biological resources of the state, to identify precise areas for immediate protection efforts. A map of these areas will be developed, with information attached to each recommended area as to the particular conservation targets therein. It can be expected that, as a result of this step in the process, along with the preceding steps, gaps in our knowledge will be identified, which can then be filled in the next cycle of this whole process.
6. **Dissemination of conservation priorities to conservation partners.** Providing GIS or paper maps and supporting information to state, Federal, municipal, and private conservation groups is the first step in implementing proactive habitat protection. Beyond that, it is likely that a detailed examination of the map of areas to be protected will reveal which organizations are most suited to protect each area, because of proximity to land already protected, or the particular priorities of the organization, or some other such factor. A list of unprotected areas suitable for protection by each active conservation group should be compiled and distributed, wherever possible in whatever venue is appropriate. Meetings between MDFW staff and staff from these other groups are likely to be particularly fruitful. An agency database of contact/mailing information of all identified conservation partners needs to be developed to aid in mass postal and electronic communications. Currently, lists exist in various forms but not in any centrally organized fashion that is easily accessible.
7. **Funding.** Admirably, when informed of their land's conservation value, many landowners choose to donate their property to a conservation group. Many conservationists choose to donate their time and skills to a land trust, for example, to help in the cause of land protection. Not surprisingly, land donations are not financially feasible for many landowners, and most land protection efforts cannot be accomplished by a purely volunteer work force. Funding for land protection in Massachusetts has decreased dramatically in recent years, especially at the state level. The tasks of



everyone involved in this Strategy will be to inform others of the importance and immediate need for increased funding from all sources for land acquisition, to use available funding as efficiently as possible to accomplish protection priorities, and to identify and cooperate on funding sources beyond the usual. Re-activating the Massachusetts Teaming With Wildlife Coalition, a group formed for the purpose of providing information about federal legislation that would provide funding for unmet wildlife needs, could be one strategy for advocacy of wildlife funding initiatives on both the state and federal levels.

8. **Updates of these protection priorities.** In five to ten years time, the information on which this Conservation Strategy is based will be out of date. The very successful BioMap project was based on data through 2000; it is clear just five years later that, while most of the areas recommended for protection are still worthwhile, new data necessitate an update. Further, both BioMap and Living Waters were aimed at conserving state-listed rare species, in general, and many of the species included in this Strategy are not addressed specifically in either BioMap or Living Waters. Throughout the implementation of the seven steps above, gaps in data should be identified and addressed, progress towards protection priorities should be compiled, and conservation partners should be cultivated. This will inform the next round of setting priorities for proactive habitat protection.

## **D. Examples of Monitoring and Adaptive Management**

Because of the large number of species of greatest conservation need in Massachusetts, as well as their habitats, it is not practical to detail all of the monitoring efforts for each species. However, three detailed examples are provided below, to illustrate how monitoring is envisioned for each.

### **A Habitat-Specific, State-Protected, Relatively Poorly Understood Invertebrate**

American Clam Shrimp (*Limnadia lenticularis*) are small crustaceans that inhabit vernal pools. As of December, 2004, there were three documented occurrences in Massachusetts, from two towns. This species is protected from “take” under the Massachusetts Endangered Species Act (MESA).

Vernal pools are relatively well-studied in Massachusetts. The Massachusetts Natural Heritage & Endangered Species Program (NHESP) delineated sites of Potential Vernal Pools across the state several years ago, through aerial photo-interpretation. The Program also certifies vernal pools which have been ground-checked and documented as functioning vernal pools.

However, there have been no systematic surveys for this species across the state, or even in vernal pools near known occurrences. During Years 9 and 10 of the monitoring cycle (see above), MassWildlife will target Potential and Certified Vernal Pools near known sites for American Clam Shrimp and, with the cooperation of volunteers and scientists from the University of Massachusetts at Amherst, survey the targeted pools for this species.

Once a series of surveys is completed, the results will be examined and future conservation actions altered on the basis of the survey results. For example, if American Clam Shrimp is found in every one of, for example, 50 targeted vernal pools near the three known sites, then MassWildlife will likely evaluate the status of American Clam Shrimp as a species of greatest conservation need and as a species protected under the state Endangered Species Act (MESA). One result could be de-listing of the species under MESA. Conversely, if 50 targeted vernal pools are surveyed for American Clam Shrimp, and the species is only found in four of those pools, all of which are long-hydroperiod pools, then it is likely that future survey efforts will be targeted mostly to other long-hydroperiod pools and that delineation of Species Habitat Polygons (see next paragraph) will be altered to include only pools with long hydroperiods.

Once sites for *L. lenticularis* are found, biologists from NHESP will delineate a Species Habitat Polygon for each site (as is the case for the sites currently known). Development and other alterations proposed for known habitat of American Clam Shrimp will be reviewed by NHESP biologists, with the intention of eliminating impact to habitat of this (and any other) state-protected rare species. Often, reviews of this kind involve surveys for rare species by consultants under the direction of NHESP, field research into questions of life history, and permanent conservation of land proven to support rare species. Information gleaned from such reviews of proposed projects is then used to alter future survey and research efforts, whether related or not to proposed development.

#### **A Habitat-Generalist, State-Protected, Well-Studied Reptile**

Blanding's Turtles (*Emydoidea blandingii*) are medium-sized turtles which inhabit many kinds of upland and wetland habitats in Massachusetts. As of December, 2004, there were 70 documented occurrences in Massachusetts, from many towns in the eastern half of the state. This species is protected from "take" under the Massachusetts Endangered Species Act.

Blanding's Turtles require large tracts of land with varied habitats to support viable populations. The intense development pressure throughout Eastern Massachusetts poses a major threat to this species. While much of the development pressure on Blanding's Turtle habitat can be monitored and protected against in the same way as American Clam Shrimp (but on a much larger scale), permanent protection of large areas of Blanding's Turtle habitat is likely to be the best long-term solution to conserving this species.

Monitoring efforts for this species include surveys by MassWildlife and cooperators to locate currently unknown populations and to establish the status of known populations. As our knowledge of Blanding's Turtles in Massachusetts increases, we will adapt our efforts so as to monitor the long-term viability of turtle populations by collecting population data as well as location. In addition, monitoring of the habitat type, Large Unfragmented Landscape Mosaics, in the range of Blanding's Turtle in Massachusetts will yield information on what kinds of fragmenting factors are having the most impact. Future monitoring efforts can then be adapted to focus on populations experiencing the worst fragmentation, and steer protection efforts such as road barriers or tunnels, and monitor these efforts success.

In addition, as populations of Blanding's Turtles are discovered, MassWildlife and its land conservation partners will target and prioritize these sites for protection. Populations that are

protected will be monitored (every 10 years) to assess the success of land protection action. We expect that many partners will be involved in these efforts. In recent years, partners and cooperators in conserving Blanding's Turtle habitat in Massachusetts have included the Massachusetts Division of Conservation and Recreation; the Trust for Public Lands; the Massachusetts Audubon Society; the Towns of Groton, Georgetown, Groveland, and Pepperell; the Nissitissit River Land Trust; the Groton Conservation Trust; the Dunstable Rural Lands Trust; the Rochester Land Trust; the Nashoba Conservation Trust; the New England Forestry Foundation; the Essex County Greenbelt Association; and the Nashua River Watershed Association. MassWildlife expects to continue working with these groups and others in future protection efforts aimed at Blanding's Turtles.

### **A Migratory Bird, Not State-Protected**

Eastern Towhees (*Pipilo erythrophthalmus*) are migratory passerines, inhabiting many types of shrubby, secondary-successional growth throughout Massachusetts. They are not protected under state or federal rare species laws.

Unlike state-protected species, Eastern Towhees and many other songbirds of conservation concern are not tracked in detail at a statewide level. Monitoring for this species will need to be in large part monitoring for its habitats, Young Forests & Shrublands and Pitch Pine/Scrub Oak, along with monitoring the species' overall status in the status by means of Breeding Bird Surveys, conducted by many volunteers and cooperators.

Therefore, one aspect of monitoring towhees will be tracking the number of acres across the state which are Young Forests & Shrublands or Pitch Pine/Scrub Oak. Both of these habitats need occasional to frequent disturbance to maintain themselves. MassWildlife intends to create and maintain examples of these disturbed habitats on its own lands, as well as working through the Landowner Incentive Program and with other conservation landowners to assist in their efforts. As far as is practicable, MassWildlife will inventory Eastern Towhees pre- and post-restoration and management actions, and will adjust disturbance protocols or increase the acreage involved in such actions, should towhee numbers continue to decrease.